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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re U.S. National Phase of:  
PCT/AT 00/00255

HELMUT BACHER, et al.

Application No.: Not yet assigned

Filed: Herewith

For: METHOD AND APPRATUS FOR  
RECYCLING PET-MATERIALS

PRELIMINARY AMENDMENT

San Francisco, CA 94111  
March 22, 2002

Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

Prior to the examination of the above-referenced application, please enter the following amendments and remarks.

IN THE CLAIMS:

Please substitute the following amended, clean versions of the indicated claims (a marked-up version of the changes to the claims is attached to this Amendment):

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3. (amended) Process according to claim 1, characterized in that also the temperature of the main processing step is kept below the plasticizing temperature of the PET-material.
  4. (amended) Process according to claim 1, characterized in that for PET-pieces and/or milled PET-bottles the pre-processing step, that preferably is performed under environmental pressure, is performed at a temperature range of 140 to 190°C, preferably 150 to 160°C, and at simultaneous mechanic treatment or, respectively, applying power that causes heating, by means of at least one mixing and/or comminuting element, wherein the

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average dwell-time of the PET-material or, respectively, the duration of pre-processing, amounts to 35 to 65 min, preferably 40 to 60 min.

5. (amended) Process according to claim 1, characterized in that for PET -foils and/or PET-fibers and/or PET-flakes, the pre-processing step, that preferably is performed under environmental pressure, is performed at a temperature range of 170 to 200°C, preferably 180 to 200°C, and at simultaneous mechanic treatment or, respectively, power applying that causes heating, by at least one mixing and/or comminuting element, wherein the average dwell-time of the PET-material or, respectively, the duration of pre-processing, amounts to 10 to 30 min, preferably 10 to 15 min.

6. (amended) Process according to claim 1, characterized in that the PET-material is subjected to the pre-processing step in a continuous flow.

7. (amended) Process according to claim 1, characterized in that the pre-processed PET-material is subjected to an intermediate storage between the pre-processing step and the main-processing step, the duration of this storage corresponds to 80 to 120 % of the duration of pre-processing step, and that the pre-processed PET-material is kept during the intermediate storage and/or during conveying to main-processing at a temperature that is as constant as possible, in particular 130 to 190°C, preferably 150 to 170°C.

8. (amended) Process according to claim 1, characterized in that during the main-processing step that is performed under vacuum, in particular under a pressure of less than 20 mbar, preferably less than 10 mbar, the pre-processed PET-pieces and/or the milled bottle material is mechanically treated at a temperature of 170 to 210°C, preferably 180 to 200°C, or is subjected to a power introduction that causes heating by at least one, preferably rotating, mixing and/or comminuting element, wherein the average dwell-time of the PET-material or the duration of the main-processing step, respectively, amounts to 40 to 100 min, preferably 50 to 90 min.

10. (amended) Process according to claim 1, characterized in that at the main-processing step that is performed under vacuum, the pre-processed PET-foils and/or PET-fibers are processed at a temperature of 160 to 210°C, preferably 170 to 205°C, or, respectively, are subjected to a mechanic power introduction that causes heating by at least one

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mixing and/or comminuting element, wherein the average dwell-time of the PET-material or the duration of the main-processing step, respectively, amounts to 5 to 25 min, in particular to 10 to 15 min.

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12. (amended) Process according to claim 5, characterized in that at least one rotating mixing and/or comminuting element is used.

13. (amended) Process according to claim 1, characterized in that the PET-material is comminuted before pre-processing to sizes of 15 to 25 mm.

14. (amended) Process according to claim 1, characterized in that the PET-material to be processed is pre-comminuted and/or washed and/or pre-dried before the pre-processing step.

15. (amended) Process according to claim 1, characterized in that the PET-material is supplied from a main-processing apparatus (4) to the extruder (8) under vacuum conditions or, respectively, that the vacuum existing within the main-processing apparatus (4) acts into the inlet section of the extruder (8).

16. (amended) Apparatus for recycling of PET-material, in which the PET-material to be processed is dried, crystallized and plasticized or, respectively, molten, and the melt, if desired after filtering, is processed to PET-granulate, for performing the process according to claim 1, characterized by two processing steps, in the first of which there is provided for pre-processing of the supplied PET-material a pre-processing device (3) having mechanical processing elements (5) for drying and simultaneously crystallizing the PET-material at elevated temperature and that this first step is followed by a second processing step comprising an evacuable main-processing device (4) having mechanical processing elements (5') for further drying, crystallizing and temperature increase of the PET-material supplied by the pre-processing device (3).

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18. (amended) Apparatus according to claim 16, characterized in that as well within the pre-processing device (3) as within the main-processing device (4) there is provided at least one rotating mixing and/or comminuting element (5, 5') which mechanically treats and heats the PET-material.

45 21. (amended) Apparatus according to claim 16, characterized in that an intermediate storage means (6) is inserted between the pre-processing device (3) and the main-processing device (4), the volume of this storage means (6) corresponds to 100 to 200 % of the volume of the pre-processing device (3).

22. (amended) Apparatus according to claim 6, characterized in that between the pre-processing device (3) and the intermediate storage means (6) and between the intermediate storage means (6) and the main-processing device (4) a thermally isolated and/or heated conveyor unit (7) each is provided, preferably a conveyor screw or an extruder.

23. (amended) Apparatus according to claim 16, characterized in that the volume of the main-processing device (4) amounts to 80 to 200% of the volume of the pre-processing device (3), in particular to 100 to 180 %.

24. (amended) Apparatus according to claim 16, characterized in that an extruder (8) is connected to the main-processing device (4), in which extruder the PET-material taken from the main-processing device (4) is heated to a temperature of 260 to 275°C and is plasticized or molten, respectively.

46 26. (amended) Apparatus according to claim 24, characterized in that the extruder (8) comprises at least one de-gassing zone (9) to which a vacuum pump (10) is connected by which within the de-gassing zone (9) a pressure of less than 40 mbar, in particular less than 10 mbar, can be adjusted.

27. (amended) Apparatus according to claim 16, characterized in that a filtration device (11) for PET-melt is connected to the extruder (8) and that, if desired, a device (12) for producing finished products or semi-finished products, for example PET-granulate, is connected to this filtration device (11).

47 29. (amended) Apparatus according to claim 16, characterized in that the pressure in the main-processing device (4) is adjustable to less than 150 mbar, preferably less than 20 mbar.

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30. (amended) Apparatus according to claim 16, characterized in that an additional heating for the pre-processing device (3) and/or for the main processing device (4) is provided.

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Claims:

1. Process for recycling of PET-material, in which the PET-material to be processed is dried, crystallized and plasticized or, respectively, molten, and subsequently, if desired after filtering, is processed to PET-granulate, characterized in that the PET-material to be processed is heated in the course of a pre-processing step and is dried and simultaneously crystallized at an elevated temperature, and that in the course of a subsequent main processing step that precedes plasticizing or melting, the PET-material is subjected under vacuum conditions to a second drying and crystallization and to a temperature that is increased when compared with the pre-processing step.
2. Process according to claim 1, characterized in that the material to be processed is pre-comminuted and/or washed and/or pre-dried before the pre-processing step.
3. Process according to claim 1 or 2, characterized in that also the temperature of the main processing step is kept below the plasticizing temperature of the PET-material.
4. Process according to any of claims 1 to 3, characterized in that for PET-pieces and/or milled PET-bottles the pre-processing step, that preferably is performed under environmental pressure, is performed at a temperature range of 140 to 190°C, preferably 150 to 160°C, and at simultaneous mechanic treatment or, respectively, applying power that causes heating, by means of at least one mixing and/or comminuting element, wherein the average dwell-time of the PET-material or, respectively, the duration of pre-processing, amounts to 35 to 65 min, preferably 40 to 60 min.
5. Process according to any of claims 1 to 3, characterized in that for PET-foils and/or PET-fibers and/or PET-flakes, the pre-processing step, that preferably is performed under environmental pressure, is performed at a temperature range of 170 to 200°C, preferably 180 to 200°C, and at simultaneous mechanic treatment or, respectively, power applying that causes heating, by at least one mixing and/or comminuting element, wherein the average dwell-time of the PET-material or, respectively, the duration of pre-processing, amounts to 10 to 30 min, preferably 10 to 15 min.
6. Process according to any of claims 1 to 5, characterized in that the PET-material is subjected to the pre-processing step in a continuous flow.
7. Process according to any of claims 1 to 6, characterized in that the pre-processed PET-material is subjected to an intermediate storage between the pre-processing

step and the main-processing step, the duration of this storage corresponds to 80 to 120 % of the duration of pre-processing step, and that the pre-processed PET-material is kept during the intermediate storage and/or during conveying to main-processing at a temperature that is as constant as possible, in particular 130 to 190°C, preferably 150 to 170°C.

8. Process according to any of claims 1 to 7, characterized in that during the main-processing step that is performed under vacuum, in particular under a pressure of less than 20 mbar, preferably less than 10 mbar, the pre-processed PET-pieces and/or the milled bottle material is mechanically treated at a temperature of 170 to 210°C, preferably 180 to 200°C, or is subjected to a power introduction that causes heating by at least one, preferably rotating, mixing and/or comminuting element, wherein the average dwell-time of the PET-material or the duration of the main-processing step, respectively, amounts to 40 to 100 min, preferably 50 to 90 min.
9. Process according to claim 8, characterized in that the main processing is performed at a pressure of less than 20 mbar, preferably less than 10 mbar.
10. Process according to any of claims 1 to 7, characterized in that at the main-processing step that is performed under vacuum, the pre-processed PET-foils and/or PET-fibers are processed at a temperature of 160 to 210°C, preferably 170 to 205°C, or, respectively, are subjected to a mechanic power introduction that causes heating by at least one mixing and/or comminuting element, wherein the average dwell-time of the PET-material or the duration of the main-processing step, respectively, amounts to 5 to 25 min, in particular to 10 to 15 min.
11. Process according to claim 10, characterized in that the main processing step is performed at a pressure less than 150 mbar, preferably less than 50 mbar.
12. Process according to any of claims 5 to 11, characterized in that at least one rotating mixing and/or comminuting element is used.
13. Process according to any of claims 1 to 12, characterized in that the PET-material is comminuted before pre-processing to sizes of 15 to 25 mm.
14. Process according to any of claims 1 to 13, characterized in that the PET-material to be processed is pre-comminuted and/or washed and/or pre-dried before the pre-processing step.

15. Process according to any of claims 1 to 14, characterized in that the PET-material is supplied from a main-processing apparatus (4) to the extruder (8) under vacuum conditions or, respectively, that the vacuum existing within the main-processing apparatus (4) acts into the inlet section of the extruder (8).
16. Apparatus for recycling of PET-material, in which the PET-material to be processed is dried, crystallized and plasticized or, respectively, molten, and the melt, if desired after filtering, is processed, preferably to PET-granulate, in particular for performing the process according to any of claims 1 to 9, characterized in that for pre-processing of the supplied PET-material a pre-processing device (3) for drying and simultaneously crystallizing the PET-material at elevated temperature is provided and that this device is followed by a main-processing device (4) for further drying, crystallizing and temperature increase of the PET-material supplied by the pre-processing device (3).
17. Apparatus according to claim 16, characterized in that the pre-processing device (3) also comminutes the PET-material.
18. Apparatus according to claim 16 or 17, characterized in that as well within the pre-processing device (3) as within the main-processing device (4) there is provided at least one rotating mixing and/or comminuting element (5, 5') which mechanically treats and heats the PET-material.
19. Apparatus according to claim 18, characterized in that for comminuting in particular of PET-pieces and/or milled bottle material at least one mixing and comminuting element (5, 5') in the pre-processing device (3) rotates with a circumferential speed of 9 to 15 m/s and in the main processing device (4) with a circumferential speed of also 9 to 15 m/s.
20. Apparatus according to claim 18, characterized in that for comminuting in particular of PET-foils and/or PET-fibers and/or PET-flakes at least one mixing and comminuting element (5, 5') is provided as well within the pre-processing device (3) as within the main processing device (4), which element, respectively, rotates with a circumferential speed of 15 to 35 m/s, preferably 20 to 30 m/s.
21. Apparatus according to any of claims 16 to 20, characterized in that an intermediate storage means (6) is inserted between the pre-processing device (3) and the main-processing device (4), the volume of this storage means (6) corresponds to 100 to 200 % of the volume of the pre-processing device (3).



22. Apparatus according to any of claims 6 to 21, characterized in that between the pre-processing device (3) and the intermediate storage means (6) and between the intermediate storage means (6) and the main-processing device (4) a thermically isolated and/or heated conveyor unit (7) each is provided, preferably a conveyor screw or an extruder.
23. Apparatus according to any of claims 16 to 22, characterized in that the volume of the main-processing device (4) amounts to 80 to 200 % of the volume of the pre-processing device (3), in particular to 100 to 180 %.
24. Apparatus according to any of claims 16 to 23, characterized in that an extruder (8) is connected to the main-processing device (4), in which extruder the PET-material taken from the main-processing device (4) is heated to a temperature of 260 to 275°C and is plasticized or molten, respectively.
25. Apparatus according to claim 24, characterized in that the extruder (8) is gas-tightly or, respectively, vacuum-tightly connected to the main-processing device (4) and that the pressure within the inlet section of the extruder (8) is connected to the pressure within the interior of the main-processing device (4), or, respectively, that the pressure within the main-processing apparatus (4) corresponds to the pressure within the inlet section of the extruder (8).
26. Apparatus according to claim 24 or 25, characterized in that the extruder (8) comprises at least one de-gassing zone (9) to which a vacuum pump (10) is connected by which within the de-gassing zone (9) a pressure of less than 40 mbar, in particular less than 10 mbar, can be adjusted.
27. Apparatus according to any of claims 16 to 25, characterized in that a filtration device (11) for PET-melt is connected to the extruder (8) and that, if desired, a device (12) for producing finished products or semi-finished products, for example PET-granulate, is connected to this filtration device (11).
28. Apparatus according to claim 27, characterized in that between the extruder (8) and the filtration device (11) a measuring device (13) for measuring the viscosity of the melt is disposed.

29. Apparatus according to any of claims 16 to 28, characterized in that the pressure in the main-processing device (4) is adjustable to less than 150 mbar, preferably less than 20 mbar.